ANTI-FOGGING SHEETS AND TRAYS USING THEREOF

FIELD OF THE INVENTION

The present invention relates to anti-fogging sheets having high anti-fogging property and antiblocking property, processes for producing the sheets, and trays (or containers or vessels) formed with the sheets.

BACKGROUND OF THE INVENTION

Hydrophobic synthetic resin sheets such as styrenic resin sheets are inferior in anti-fogging property. Therefore, when such a sheet is shaped or molded into a tray to store a food, water vapor is attached to the surface of the tray as small droplets due to temperature and humidity changes. As a result, the tray gets clouded (misty or dim) thereby deteriorating transparency.

Japanese Patent Publication No. 62538/1988 (JP-63-62538B) discloses a method for coating a styrenic resin film with an aqueous solution comprising (A) a sucrose fatty acid ester, (B) a non-modified polyvinyl alcohol having a polymerization degree of not more than 800, and (C) a silicone emulsion at a proportion (net weight ratio) of (A)/(B)/(C) = 1/0.5 to 2/0.5 to 3.

Japanese Patent Application Laid-Open No. 309785/1998 (JP-10-309785A) discloses a styrenic resin sheet in which one side of the sheet is coated with 10 to 50 mg/m^2 of a mixture of a sucrose fatty acid ester and a

methyl cellulose, the coated layer is further coated with a silicone oil, and the other side of the sheet is coated with a silicone oil. In this document, the amount of the silicone oil coated on the anti-fogging treating agent is described as 2 to 14 mg/m^2. Moreover, Comparative Example 5 shows that blocking is generated in a sheet having a coating amount of the silicone oil of 1.2 mg/m^2 relative to the sucrose fatty acid ester of 18 mg/m^2.

Furthermore, Japanese Patent No. 3241797 description discloses that at least one side of a polymer film is coated with a surface-treating agent comprising a sucrose fatty acid ester, a silicone emulsion, and a polysaccharide and/or a hydrophilic polymer (excluding a polyvinyl alcohol). In this surface-treating agent, the proportion of the silicone emulsion as a solid matter is 20 to 1000 parts by weight relative to 100 parts by weight of the sucrose fatty acid ester.

A resin sheet for shaping into a tray (e.g., a styrenic resin sheet) is, for example, formed by melt-kneading a resin, extrusion-molding the kneaded product to a sheet form, biaxially drawing the resultant sheet, coating an anti-fogging agent on the sheet, and drying the coated sheet to roll up in a roll form. Moreover, when shaping or molding a tray, the tray is shaped or molded by paying out the resin sheet from the roll, and thermoforming the sheet. However, along with rolling up of the resin sheet, the anti-fogging agent of the sheet

is contacted with the non-treated surface of the resin sheet and transferred thereto. Further, in the process for shaping or molding the tray, probably because the anti-fogging agent is transferred by contacting with a heated member such as a hot plate, anti-fogging property or antiblocking property of the resin sheet or tray is remarkably decreased. In particular, in the case shaping or molding a tray by deep drawing, anti-fogging property is significantly deteriorated. Moreover, a molding machine to be used is stained with the anti-fogging agent. Further, a relatively large amount of silicone oil is necessary for increasing mold-releasing property of the anti-fogging sheet.

These anti-fogging sheets or films containing a silicone oil are excellent in antiblocking property. However, anti-fogging property of these anti-fogging sheets is not still enough. That is, the anti-fogging sheets are, for example, low in anti-fogging property (anti-fogging property at high temperature) against water vapor generated from a high-temperature content which is put in a tray using the sheets, in particular, low in anti-fogging property (anti-fogging property at low temperature) against water vapor or dew condensation when a content containing water (e.g., a food) is charged in a tray using the sheets and kept at a low temperature. Further, anti-fogging property is significantly deteriorated by rolling up the sheet, or shaping the sheet

into a tray.

Japanese Patent Application Laid-Open No. 46232/2002 (JP-2002-46232A) and Japanese Patent Application Laid-Open No. 47366/2002 (JP-2002-47366A) disclose a polystyrenic sheet in which one surface is coated with at least one anti-fogging agent selected from the group consisting of a sucrose fatty acid ester and a polyglycerin fatty acid ester at a coating amount of 5 to 30 mg/m^2, and the other surface is coated with a mold-releasing agent comprising an ether-series polymer (a polyoxyethylene-polyoxypropylene block copolymer) and others at a coating amount of 3 to 30 mg/m^2. Japanese Patent Application Laid-Open No. 86639/2002 (JP-2002-86639A) discloses a polystyrenic anti-fogging resin sheet in which one surface is coated with an anti-fogging agent comprising at least one fatty acid ester selected from the group consisting of a sucrose fatty acid ester and a polyglycerin fatty acid ester, an ether-series polymer (a polyoxyethylene-polyoxypropylene block copolymer, a polyethylene glycol), and a polyvinyl alcohol, and the other surface is coated with a mold-releasing agent comprising an ether-series polymer (a polyoxyethylene-polyoxypropylene block copolymer, a polyethylene glycol).

However, since the ether-series polymer is used as the mold-releasing agent, these anti-fogging sheets are significantly deteriorated in antiblocking property or mold-releasing property compared with a sheet using a

silicone oil. Further, in the case where the resin sheet is contacted with a heated member such as a hot plate in the forming process, a hot plate is stained thereby transparency is adversely affected, and the quality of a tray formed with the sheet becomes low.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a resin sheet having high anti-fogging property and mold-releasing property, and a process for producing the same, as well as a tray (or container or vessel) using the sheet.

Another object of the present invention is to provide an anti-fogging resin sheet capable of maintaining high anti-fogging property even in the steps such as rolling up, thermoforming or other step, and a process for producing the same, as well as a tray (or container or vessel) using the anti-fogging resin sheet.

It is still another object of the present invention to provide an anti-fogging resin sheet having high mold-releasing property (or antiblocking property) even in the case using a silicone oil at a small amount, and a process for producing the same, as well as a tray (or container or vessel) using the anti-fogging resin sheet.

The inventor of the present invention made intensive studies to achieve the above objects and finally found that both high anti-fogging property and mold-

releasing property are imparted to a base resin sheet having a specific surface conformation (or shape) by coating at least one side of the base resin sheet with a component comprising a polyhydric alcohol fatty acid ester and a specific hydrophilic polymer. The present invention was accomplished based on the above findings.

That is, the coated resin sheet of the present invention comprises a base resin sheet and a coating layer formed on at least one side of the base resin sheet, wherein the coating layer comprises a polyhydric alcohol fatty acid ester and a hydrophilic polymer, a projection with a height of 0.2 to 2 μm is formed on the surface of the coating layer, and an average density (or number) of the projection is 5 to 50 per square millimeter. The polyhydric alcohol fatty acid ester may be selected from various fatty acid esters, for example, a sucrose fatty acid ester, a polyglycerin fatty acid ester, and others. Moreover, the hydrophilic polymer may be selected from a non-ether-series hydrophilic polymer (e.g., a polysaccharide, an acrylic acid-series polymer or a salt thereof, and a homo- or copolymer of vinylpyrrolidone) and an ether-series hydrophilic polymer (e.g., a polyoxyethylene-polyoxypropylene block copolymer, and a nonionic surfactant having an oxyethylene unit). Further, the coated layer may comprise a silicone oil such as a silicone emulsion (or emulsified silicone).

The proportions of the above components may for

example be, relative to 100 parts by weight of the polyhydric alcohol fatty acid ester, about 1 to 100 parts by weight of the hydrophilic polymer and about 0 to 100 parts by weight (particularly about 0 to 50 parts by weight) of the silicone oil.

In the coated resin sheet, the coating layer may be formed on one side of the base resin sheet, and a wetting index of the other side of the base resin sheet may be about 30 to 55 dyn/cm. On the other side of the base resin sheet, a projection with a height of 0.2 to 2 μm may be formed at an average density (or number) of 5 to 50 per square millimeter. Moreover, a release layer comprising a silicone oil may be formed on the other side of the base resin sheet.

The base resin sheet may comprise a styrenic resin. In particular, the base resin sheet may comprise 100 parts by weight of a styrenic resin, and 0.001 to 5 parts by weight of a crosslinked organic particle. Moreover, the base styrenic resin sheet may comprise 100 parts by weight of a styrenic resin, 0.2 to 1.5 parts by weight of a rubber-reinforced styrenic resin, and 0.003 to 0.05 parts by weight of a crosslinked styrenic resin particle.

The present invention further includes a process for producing the coated resin sheet, which comprises forming a coating layer on at least one side of a base resin sheet having a projection with a height of 0.2 to 2 μm, wherein an average density of the projection is 5 to 50

per square millimeter. Furthermore, the present invention includes a tray formed with the coated resin sheet.

Incidentally, throughout this description, the meaning of the term "sheet" includes a two-dimensional material, for example, a film, a plate, or others. The "ether-series hydrophilic polymer" also includes an ethylene oxide adduct whose molecular weight is increased by addition of ethylene oxide.

DETAILED DESCRIPTION OF THE INVENTION

[Coating (anti-fogging) layer]

The coated resin sheet of the present invention comprises a base resin sheet and a coating (anti-fogging) layer formed on at least one side of the base resin sheet, and the coating layer comprises a polyhydric alcohol fatty acid ester, a hydrophilic polymer, and if necessary a silicone oil. Further, the surface of the coating layer has a projection with a height of 0.2 to 2 μm, and an average density of the projection is 5 to 50 per square millimeter.

(Polyhydric alcohol fatty acid ester)

The fatty acid ester constituting the coating layer (or anti-fogging layer) may comprise an ester of a polyhydric alcohol and a fatty acid (particularly a higher fatty acid). Examples of the polyhydric alcohol include a C_{2-12}alkylene glycol such as ethylene glycol, propylene glycol, butanediol, hexanediol, or neopentyl glycol; a (poly)oxyC_{2-4}alkylene glycol such as diethylene glycol,

triethylene glycol, a polyethylene glycol, dipropylene glycol, tripropylene glycol, a polypropylene glycol, or a polytetramethylene glycol; a polyhydroxy compound (or polyhydric alcohol) such as glycerin, a polyglycerin having a polymerization degree of about 2 to 20 (e.g., diglycerin, triglycerin, tetraglycerin, polyglycerin), trimethylolethane, trimethylolpropane, pentaerythritol, or a saccharide (e.g., sucrose, sorbitol, mannitol, xylitol, maltitol, sorbitan, an oligosaccharide), and others. The polyhydric alcohol(s) may be used singly or in combination.

The preferred polyhydric alcohol includes a compound having not less than three hydroxyl groups, for example, glycerin, a polyglycerin having a polymerization degree of about 2 to 15, and a saccharide (e.g., sucrose).

The fatty acid includes, for example, a saturated C_{6-30}fatty acid such as caproic acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, behenic acid, or montanic acid; an unsaturated C_{10-24}fatty acid such as linderic acid, palmitoleic acid, oleic acid, elaidic acid, isooleic acid, erucic acid, linoleic acid, or linolenic acid; and others. The fatty acid(s) may be used singly or in combination to form a mixed acid ester.

Among these fatty acids, a saturated or unsaturated C_{8-24}fatty acid, in particular a saturated fatty acid, is preferred. The fatty acid is, for example, often a fatty

acid containing a C_{10-22}fatty acid as a main component (e.g., a fatty acid containing a saturated C_{12-18}fatty acid such as lauric acid at a proportion of at least not less than 50 mol%).

As the fatty acid ester useful for improving anti-fogging or other property (properties), a sucrose fatty acid ester, and a polyglycerin fatty acid ester are preferred. The fatty acid ester(s) may also be used singly or in combination. Examples of the sucrose fatty acid ester include a mono- to hexaester of sucrose and a saturated C_{8-24}fatty acid (particularly a saturated C_{10-22}fatty acid), e.g., a sucrose mono- to hexacaprylate, a sucrose mono- to hexalaurate, a sucrose mono- to hexastearate, and a sucrose mono- to hexabehenate; a mono- to hexaester of sucrose and an unsaturated C_{12-24}fatty acid (particularly an unsaturated C_{16-22}fatty acid), e.g., a sucrose mono- to hexaoleate; and others.

As the polyglycerin fatty acid ester, there may be mentioned a mono- to dodecaester of a polyglycerin having a polymerization degree of about 2 to 16 and a saturated C_{8-24}fatty acid (particularly a saturated C_{10-22}fatty acid), e.g., a tetraglycerin mono- to tetracaprylate, a hexaglycerin mono- to hexacaprylate, a decaglycerin mono- to decacaprylate, a tetraglycerin mono- to tetralaurate, a hexaglycerin mono- to hexalaurate, a decaglycerin mono- to decalaurate, a tetraglycerin mono- to tetrastearate, a hexaglycerin mono- to hexastearate, a decaglycerin mono-

to decastearate, a tetraglycerin mono- to tetrabehenate, a hexaglycerin mono- to hexabehenate, and a decaglycerin mono- to decabehenate; a mono- to dodecaester of a polyglycerin having a polymerization degree of about 2 to 16 and an unsaturated C_{16-24}fatty acid (particularly an unsaturated C_{16-22}fatty acid), e.g., a tetraglycerin mono- to tetraoleate, a hexaglycerin mono- to hexaoleate, a decaglycerin mono- to decaoleate, a tetraglycerin mono- to tetraerucate, a hexaglycerin mono- to hexaerucate, and a decaglycerin mono- to decaerucate; or others.

The HLB (hydrophile-lipophile balance) of the fatty acid ester is not particularly limited, and may for example be about 2 to 20, preferably about 5 to 18, more preferably about 10 to 18, and usually about 12 to 17.

(Hydrophilic polymer)

The hydrophilic polymer includes a non-ether-series hydrophilic polymer and an ether-series hydrophilic polymer.

The non-ether-series hydrophilic polymer includes various hydrophilic polymers, and for example, a polysaccharide (an oligosaccharide, a cellulose derivative), and a polymer of a vinyl monomer, or a salt thereof. The hydrophilic polymer(s) may be used singly or in combination. Incidentally, in order to enhance anti-fogging property, it is preferred that the hydrophilic polymer does not include a polyvinyl alcohol.

Among the non-ether-series hydrophilic polymer(s),

the polysaccharide may for example be a single polysaccharide, a complex (or combined) polysaccharide, or a derivative thereof. The polysaccharide includes, for example, a polysaccharide containing an oligosaccharide, a starch derivative, a cellulose derivative, and others. These polysaccharides are used as foods or food additives, and have high safety.

Examples of the polysaccharide include a starch, phytoglycogen, fructan, galactomannan, glucomannan, mannan, barley and oat glucan, cellulose, hemicellulose, β-1,3-glucan, galactan, araban, xylan, arabogalactan, araboxylan, araboglucan, pectin, gum acacia (or gum arabic), tragacanth gum, locust bean gum, guar gum, mesquite gum, carageenin, glucuronoxylan, laminaran, inulin, lichenin, fructosan, chitin, chitosan, alginic acid or a salt thereof (e.g., sodium alginate), hyaluronic acid, chondroitin sulfate, charonin sulfate, gelatin, agar, fucoidin, hibiscus, curdlan, xanthan gum, pullulan, dextran, cyclodextrin, nigeran, levan, and others. Incidentally, as the oligosaccharide (or oligosaccharide alcohol), there may be mentioned a disaccharide, a trisaccharide, a tetrasaccharide, a pentasaccharide, a hexasaccharide, a heptasaccharide, a octasaccharide, a decasaccharide, or others, and usually a oligosaccharide of a trisaccharide to a octasaccharide (e.g., tetrasaccharide). The oligosaccharide may be a simple saccharide, or may be used as an oligosaccharide containing

a plurality of saccharides (e.g., containing at least a tetrasaccharide). Moreover, the oligosaccharide may contain a branched sugar alcohol.

The starch derivative includes, for example, white dextrin, yellow dextrin, british gum, an oxidized starch, an acid-treated starch, an α-starch, a highly amylose-containing starch, a dialdehyde starch, a starch acetate, a sodium glycolate starch, a hydroxyethyl starch, a phosphate starch, a cation starch, a crosslinked starch, an ester of a starch and an organic acid, an ester of a starch and an inorganic acid, an alkylated starch ether and an alkylated substituted starch ether, a graft-polymerized starch, and a derivative thereof.

Examples of the cellulose derivative include an alkylcellulose (e.g., a C_{1-6}alkylcellulose such as a methylcellulose, an ethylcellulose, or a propylcellulose), a carboxyalkylcellulose (e.g., a carboxyC_{1-6}alkylcellulose such as a carboxymethylcellulose, a carboxyethylcellulose, or a carboxypropylcellulose), a hydroxyalkylcellulose (e.g., a hydroxyC_{1-6}alkylcellulose such as a hydroxymethylcellulose, a hydroxyethylcellulose, or a hydroxypropylcellulose), a hydroxyalkylalkylcellulose (e.g., a hydroxyethylmethylcellulose, a hydroxypropylmethylcellulose), a soluble cellulose acetate, an inorganic acid ester of a cellulose (e.g., a cellulose sulfate, a cellulose phosphate), and others.

Used as the polysaccharide is the oligosaccharide, or the cellulose derivative (e.g., an alkylcellulose, a carboxyalkylcellulose, a hydroxyalkylcellulose, a hydroxyalkylalkylcellulose) in many cases.

The hydrophilic polymer includes a water-soluble polymer, a water-dispersible polymer, and a water-swelling polymer. Examples of the hydrophilic polymer includes a homo- or copolymer containing a vinyl monomer (e.g., a hydroxyl group-containing monomer, a carboxyl group- or sulfonic acid group-containing monomer, an amide group-containing monomer, a monomer containing a basic nitrogen atom, or a vinyl ether-series monomer) as a constitutive component.

As the hydroxyl group-containing monomer, for example, there may be mentioned a hydroxyalkyl acrylate such as 2-hydroxyethyl acrylate, or 2-hydroxypropyl acrylate, a hydroxyalkyl methacrylate corresponding to the hydroxyalkyl acrylate, a polyethylene glycol mono(meth)acrylate, and others. The carboxyl group-containing monomer includes, for example, (meth)acrylic acid, maleic acid, fumaric acid, and itaconic acid. Examples of the sulfonic acid group-containing monomer include ethylenesulfonic acid, styrenesulfonic acid, and others. The amide group-containing monomer includes, for example, (meth)acrylamide, and the monomer containing a basic nitrogen atom includes, for example, N,N-dimethylaminoethyl acrylate, N,N-diethylaminoethyl

acrylate, or a methacrylate corresponding thereto, and vinylpyrrolidone. As the vinyl ether-series monomer, there may be mentioned, for example, an alkyl vinyl ether such as vinyl methyl ether, vinyl ethyl ether, vinyl isopropyl ether, vinyl butyl ether, or vinyl isobutyl ether.

The hydrophilic polymer containing the monomer as a constitutive component may be a copolymer of the monomer and a monomer such as a (meth)acrylate (e.g., a C_{1-10}alkyl (meth)acrylate), styrene, or a vinyl carboxylate (e.g., vinyl acetate).

The preferred hydrophilic polymer includes a water-soluble polymer (e.g., an acrylic polymer, a vinyl-series polymer). For example, such a polymer is preferably a polymer having a carboxyl group or a salt thereof [e.g., a (meth)acrylic polymer and a salt thereof, such as a poly((meth)acrylic acid), a (meth)acrylic acid-maleic anhydride copolymer, a (meth)acrylic acid-vinylsulfonic acid copolymer, or a (meth)acrylic acid-methyl methacrylate copolymer], a vinyl-series polymer containing an ether group or basic nitrogen atom [e.g., a poly(alkyl vinyl ether), an alkyl vinyl ether-maleic anhydride copolymer, or a polymer (homo- or copolymer) having a vinylpyrrolidone unit such as a polyvinylpyrrolidone]. Examples of the salt of the (meth)acrylic polymer include an alkali metal salt such as a sodium salt or a potassium salt, an ammonium salt,

and an organic amine salt.

Among the hydrophilic polymers, a (meth)acrylic polymer or a salt thereof (an acrylic polymer or a salt thereof, e.g., a sodium polyacrylate), and a homo- or copolymer of vinylpyrrolidone (e.g., a polyvinylpyrrolidone) which are approved as a food additive are preferred.

The ether-series hydrophilic polymer may have at least an oxyethylene unit, and includes an ethylene oxide adduct, a random or block polymer of ethylene oxide, or others. The ether-series hydrophilic polymer has surface-active property in many cases. The representative ether-series hydrophilic polymer includes a polyoxyethylene-polyoxypropylene block copolymer (hereinafter, may be sometimes simply referred to as a POE-POP block copolymer), and a nonionic surfactant containing an oxyethylene unit. The ether-series hydrophilic polymer(s) may be used singly or in combination.

The polyoxyethylene-polyoxypropylene block copolymer (POE-POP block copolymer) is a copolymer comprising both an oxyethylene block (unit) $-(CH_2CH_2O)_m-$ and an oxypropylene block (unit) $-(CH(CH_3)CH_2O)_n-$, and the content [m/(m+n) x 100] of the ethylene oxide chain in the copolymer may be about 10 to 95% (wt.%) (preferably about 20 to 90% (wt.%), more preferably about 40 to 90% (wt.%), and particularly about 50 to 90% (wt.%)). The block

structure of the block copolymer is not particularly limited, and may be a diblock structure formed with an oxyethylene block and an oxypropylene block, a triblock structure formed by bonding an oxyethylene block to the both ends of an oxypropylene block, and others. The copolymer having the triblock structure may be represented by the following formula:

$$HO-(CH_2CH_2O)_{m1}-(CH(CH_3)CH_2O)_n-(CH_2CH_2O)_{m2}-H \quad (m1+m2=m)$$

The molecular weight of the polyoxyethylene-polyoxypropylene block copolymer (POE-POP block copolymer) is not particularly limited. The weight-average molecular weight thereof may for example be selected within a range from about 1,000 to 50,000, preferably about 3,000 to 30,000, and more preferably 5,000 to 30,000 (e.g., about 10,000 to 25,000), and may be usually about 8,000 to 20,000 (e.g., about 10,000 to 20,000).

Examples of the nonionic surfactant include a polyoxyethylene alkyl ether (e.g., a polyoxyethylene C_{12-24}alkyl ether), a polyoxyethylene alkyl aryl ether (e.g., a polyoxyethylene C_{6-18}alkyl phenyl ether), a polyoxyethylene polyhydric alcohol fatty acid ester (an adduct of ethylene oxide to a polyhydric alcohol fatty acid ester) (e.g., a polyoxyethylene sorbitan fatty acid ester, a polyoxyethylene glycerin fatty acid ester, a polyoxyethylene sorbitol fatty acid ester, a polyoxyethylene castor oil), a polyoxyethylene alkylamine (e.g., a polyoxyethylene C_{10-24}alkylamine), and a

polyoxyethylene fatty acid amide (e.g., a polyoxyethylene C_{8-24}fatty acid amide). The nonionic surfactant(s) may be used singly or in combination. As the nonionic surfactant, the polyoxyethylene polyhydric alcohol fatty acid ester (e.g., the polyoxyethylene sorbitan fatty acid ester) is usually employed. Incidentally, the higher fatty acid (the C_{6-30}saturated fatty acid, the C_{10-24}unsaturated fatty acid) described in the paragraph of the fatty acid ester may be utilized as the fatty acid.

In the nonionic surfactant, the mole number of the adducted oxyethylene unit may be about 2 to 100, preferably about 5 to 50 (e.g., about 10 to 50), and more preferably about 10 to 30. Further, the HLB of the nonionic surfactant may for example be about 5 to 20, and preferably about 10 to 20 (e.g., about 10 to 18).

In order to maintain high anti-fogging property, the non-ether-series hydrophilic polymer may be used in combination with the ether-series hydrophilic polymer. In the case using both the polymers in combination, the proportion of the ether-series hydrophilic polymer relative to 100 parts by weight of the non-ether-series hydrophilic polymer may be about 0.1 to 1000 parts by weight (e.g., about 1 to 700 parts by weight, and preferably about 10 to 500 parts by weight). As the ether-series hydrophilic polymer, a POE-POP block copolymer and a nonionic surfactant having an oxyethylene unit may be used in combination, and the proportion of the nonionic

surfactant is about 0.1 to 1000 parts by weight (e.g., about 1 to 500 parts by weight, and preferably about 5 to 250 parts by weight) relative to 100 parts by weight of the POE-POP block copolymer.

(Silicone oil)

In the present invention, the coating layer may comprise a silicone oil having high antiblocking property or mold-releasing property. The species of the silicone oil is not particularly limited, and the silicone oil include, for example, an alkylpolysiloxane such as a dimethylpolysiloxane, a diethylpolysiloxane, or a trifluoropropylpolysiloxane; an arylpolysiloxane such as a diphenylpolysiloxane; an alkylarylpolysiloxane such as a methylphenylpolysiloxane; or others. The silicone oil may be a chain (or linear) polysiloxane, or a cyclic polysiloxane.

Further, the silicone oil may be a modified silicone oil as far as the silicone oil ensures antiblocking property or mold-releasing property. Example of the modified silicone oil include a silicone oil having a hydroxyalkyl group (e.g., a hydroxyC_{2-4}alkyl group such as hydroxyethyl group), a polyoxyalkylene group, an amino group, a N-alkylamino group, a glycidyl group or epoxy group, or a polymerizable group (e.g., vinyl group, (meth)acryloyl group).

The silicone oil(s) may be also used singly or in combination. Among these silicone oils, a general-purpose

dimethylpolysiloxane is usually employed. The silicone oil may be in various forms, and usually employed in the form of a silicone emulsion (a emulsion formed by emulsifying and dispersing a silicone oil) in practical cases.

The viscosity of the silicone oil is not particularly limited, and for example, the Ostwald viscosity at a room temperature (15 to 25°C) is about 50 to 50000 centistokes (0.5×10^{-4} to 500×10^{-4} m^2/s), preferably about 100 to 30000 centistokes (1×10^{-4} to 300×10^{-4} m^2/s), and more preferably about 150 to 30000 centistokes (1.5×10^{-4} to 300×10^{-4} m^2/s).

In coating layer, each component may be used in combination in such a range that anti-fogging property or antiblocking property (or mold-releasing property) is adversely affected. As such a combination, there may be mentioned, for example, the following combination: at least one fatty acid ester selected from the group consisting of a sucrose fatty acid ester and a polyglycerin fatty acid ester (in particular a fatty acid ester comprising at least a sucrose fatty acid ester); at least one non-ether-series polymer selected from the group consisting of a polysaccharide, an acrylic polymer or a salt thereof, and a homo- or copolymer of vinylpyrrolidone (in particular a non-ether-series polymer comprising at least a homo- or copolymer of vinylpyrrolidone); at least one ether-series hydrophilic polymer selected from the

group consisting of a polyoxyethylene-polyoxypropylene block copolymer, and a nonionic surfactant having an oxyethylene unit (in particular an ether-series hydrophilic polymer comprising at least a polyoxyethylene-polyoxypropylene block copolymer); and a silicone oil (in particular an emulsion of silicone such as a dimethylpolysiloxane).

In the coating layer (or anti-fogging layer), the proportion of each component may be selected so that anti-fogging property or antiblocking property (or mold-releasing property) is deteriorated. The proportion of the hydrophilic polymer may for example be about 1 to 100 parts by weight, preferably about 3 to 70 parts by weight, and more preferably about 5 to 50 parts by weight relative to 100 parts by weight of the polyhydric alcohol fatty acid ester. The amount of the silicone oil may for example be about 0 to 100 parts by weight (e.g., about 1 to 100 parts by weight), preferably about 0 to 50 parts by weight (e.g., about 1 to 50 parts by weight), and more preferably about 0 to 30 parts by weight (e.g., about 1 to 30 parts by weight) relative to 100 parts by weight of the polyhydric alcohol fatty acid ester. According to the present invention, even when the amount of the silicone oil is small (in particular, even when no silicone oil is used), both high antiblocking property and mold-releasing property can be obtained.

Incidentally, each ingredient constituting the

above components may be used singly or in combination. In the case where a plurality of ingredients (e.g., a first ingredient and a second ingredient) are used in combination, the proportion of the second ingredient relative to 100 parts by weight of the first ingredient may be about 0.1 to 1000 parts by weight (e.g., about 1 to 500 parts by weight, and preferably about 5 to 250 parts by weight). For instance, in the case using the sucrose fatty acid ester and the polyglycerin fatty acid ester in combination as the polyhydric alcohol fatty acid ester, the proportion of the latter component may for example be selected from a range of about 1 to 500 parts by weight (e.g., about 5 to 300 parts by weight, and preferably about 5 to 100 parts by weight) relative to 100 parts by weight the former component. When the polysaccharide and the vinylpyrrolidone-series polymer are used in combination as the hydrophilic polymer, the proportion of the both components may be selected from a wide range. For example, the proportion of the latter component may be selected from a range of about 0.1 to 1000 parts by weight (e.g., about 1 to 500 parts by weight, and preferably about 10 to 250 parts by weight) relative to 100 parts by weight of the former component.

Incidentally, the coating layer may comprise various additives, for example, a stabilizer (e.g., an antioxidant, a ultraviolet ray absorbing agent), a filler, a coloring agent, an antistatic agent, a flame retardant,

a lubricant, a wax, an antiseptic agent (or preservative), a viscosity adjustment (or viscosity controller), a thickening agent, a leveling agent, and an antifoaming agent.

In the present invention, the projection with a height of 0.2 to 2 μm is formed on the surface of the coating layer, and an average density (or number) of the projection is about 5 to 50 per square millimeter, preferably about 5 to 40 per square millimeter, and more preferably about 5 to 35 (particularly about 5 to 30) per square millimeter. The coated resin sheet of the present invention having such a projection ensures excellent antiblocking property even in a small proportion of the silicone oil. The coated layer having such a projection formed on the surface thereof may comprise a projection such as a particle in the coated layer, and usually, may be prepared by using a base resin sheet having such a projection formed on the surface thereof. The configuration (or shape) of the projection is not particularly limited, and is usually a protruding structure of a particulate structure such as a spherical shape, an elliptical shape, or a polygonal shape.

[Base resin sheet]

The base resin sheet may be formed from various thermoplastic resins having film- or sheet-formability (or shapability), for example, an olefinic resin such as a polyethylene-series resin (e.g., a polyethylene, an ethylene-ethyl acrylate copolymer, an ionomer), a

polypropylene-series resin (e.g., a polypropylene, a propylene-ethylene copolymer), or a poly(4-methylpentene-1); a vinyl alcohol-series resin such as a polyvinyl alcohol, or a ethylene-vinyl alcohol copolymer; a vinyl chloride-series resin such as a polyvinyl chloride; a styrenic resin; a homo- or copolyester-series resin having an alkylene arylate unit, such as a polyethylene terephthalate or a polybutylene terephthalate; a nylon or polyamide-series resin; a polyacrylonitrile-series resin; a polycarbonate-series resin; a polyphenylene oxide-series resin; a polysulfone-series resin; and a cellulose derivative. The resin(s) may be used singly or in combination. Moreover, the base resin sheet may be a single layer sheet, or a laminated sheet formed by laminating a plurality of resin layers. The thickness of the base resin sheet may be selected depending on the application, and may for example be about 10 μm to 5 mm, and preferably about 25 μm to 1 mm. In the case utilizing the base resin sheet for shaping or molding a tray, the thickness of the base resin sheet may for example be about 50 μm to 5 mm, preferably about 100 to 3000 μm (e.g., about 100 to 1000 μm), and more preferably about 130 to 500 μm.

The preferred base resin sheet is a sheet having shaping processability (mold-processability), particularly a hydrophobic synthetic resin sheet. Such a sheet may for example comprise an olefinic resin (particularly a polypropylene-series resin), a

polyester-series resin (particularly a polyethylene terephthalate-series resin), and a styrenic resin. In particular, a base resin sheet having high shaping processability, for example, a styrenic resin sheet is preferred. Incidentally, a polystyrene sheet has high transparency.

The styrenic resin includes a homopolymer containing an aromatic vinyl monomer (e.g., styrene, vinyltoluene, α-methylstyrene) as a constitutive component, a copolymer of an aromatic vinyl monomer and a copolymerizable monomer, and a mixture thereof. More specifically, examples of the styrenic resin include a general-purpose polystyrene (GPPS), a rubber-reinforced (or rubber-containing) polystyrene (high impact polystyrene: HIPS), a polystyrene-polybutadiene-polystyrene block copolymer, an acrylonitrile-styrene copolymer (AS resin), an acrylonitrile-butadiene-styrene copolymer (ABS resin), a styrene-butadiene block copolymer, an AXS resin obtained by graft-polymerizing acrylonitrile (A) and styrene (S) to a rubber component (X) (e.g., an acrylic rubber, a chlorinated polyethylene, an ethylene-propylene rubber (EPDM), an ethylene-vinyl acetate copolymer), a styrene-methyl methacrylate copolymer, an acrylonitrile-styrene-methyl methacrylate copolymer, and others. The styrenic resin(s) may be used singly or in combination.

In order to form a projection on the coated layer,

the projection may be formed on the surface of the base resin sheet. The projection in the surface of the base resin sheet may be formed by coating a layer containing a projection (such as a particle) on the surface of the base resin sheet, or formed by kneading a projection (such as a particle) into the base resin sheet. Among them, from the viewpoint of convenience, a method of kneading a particle into the base resin sheet, that is, a method in which the base resin sheet is composed of a resin and a particle is preferred. The particle includes an organic particle and an inorganic particle. The particle(s) may be used singly or in combination.

Examples of the inorganic particle include a metal powder, a white carbon, a metal silicate (e.g., calcium silicate, aluminum silicate, magnesium silicate, magnesium aluminosilicate), a mineral particle (e.g., a zeolite, a diatomaceous earth, a burned diatomaceous earth, a talc, a kaolin, a sericite, a bentonite, a smectite, a clay), a metal carbonate (e.g., magnesium carbonate, heavy calcium carbonate, light calcium carbonate), a metal oxide (e.g., alumina, silica, zinc oxide, titanium dioxide), a metal hydroxide (e.g., aluminum hydroxide, calcium hydroxide, magnesium hydroxide), and a metal sulfate (e.g., calcium sulfate, barium sulfate).

The organic particle may comprise a thermoplastic resin or a thermosetting resin, a rubber particle, and others. The thermoplastic resin includes, for example, a

crosslinked or non-crosslinked organic particle such as a polyolefinic resin, a styrenic resin, an acrylic resin, a polycarbonate-series resin, a polyester-series resin, a polyamide-series resin, a polyphenylene oxide-series resin, or a vinyl-series resin; a wax particle (e.g., Fischer-Tropsch wax, an ester wax, a higher fatty acid or a salt thereof, a higher fatty acid ester, and a higher fatty acid amide); and others. Among these thermoplastic resins, the preferred resin includes a polyolefinic resin (e.g., a crosslinked polyethylene, a crosslinked polypropylene), a styrenic resin (e.g., a crosslinked polystyrene, a crosslinked polyvinyltoluene, a crosslinked styrene-methyl methacrylate copolymer), an acrylic resin (e.g., a crosslinked poly(methyl methacrylate)), and others. The thermosetting resin is not particularly limited to a specific one, and includes an organic particle such as a silicone-series resin, an amino resin (e.g., a urea resin, a melamine resin, a benzoguanamine resin), a polyurethane-series resin, or an epoxy-series resin. As the rubber particle, there may be mentioned, for example, a diene-series rubber, an acrylic rubber, an ethylene-α-olefin-polyene copolymer, a silicone rubber, a hydrogenerated diene-series rubber, and others. Further, these particles (in particular a rubber particle) may be a particle dispersed in a thermoplastic resin of a matrix.

Among these particles, from the viewpoint of

mold-releasing property (antiblocking property) and compatibility to the resin, it is preferred to use a crosslinked organic particle, particularly a crosslinked resin particle (e.g., a polyolefinic resin, an acrylic resin, a styrenic resin, a silicone-series resin), or a crosslinked or grafted rubber particle which may be dispersed in the matrix resin (e.g., a crosslinked or grafted diene-series rubber particle, or a hydrogenerated diene-series rubber particle). A preferred crosslinked organic particle, in view of compatibility, comprises a resin as the same type as the resin constituting the base resin sheet is preferred. The crosslinked organic particle(s) may be used singly or in combination.

The proportion of the particle (e.g., the crosslinked organic particle) is about 0.001 to 5 parts by weight, preferably about 0.003 to 3 parts by weight, and more preferably about 0.005 to 2 parts by weight relative to 100 parts by weight of the resin (e.g., the styrenic resin).

Further, from the viewpoint of compatibility between the resin constituting the sheet and the particle, as the particle, a crosslinked or graft rubber-dispersed resin, and a crosslinked resin particle are preferably used in combination. In this case, the proportion of the crosslinked resin particle is about 0.003 to 0.05 parts by weight and preferably about 0.005 to 0.03 parts by weight relative to 100 parts by weight of the resin constituting

the sheet, and the proportion of the rubber particle-dispersed resin is about 0.2 to 1.5 parts by weight and preferably about 0.3 to 1.2 parts by weight relative to 100 parts by weight of the resin constituting the sheet.

In the case where the base resin sheet comprises a styrenic resin, it is preferred to use a crosslinked organic particle, e.g., a crosslinked styrenic resin particle such as a crosslinked polystyrene particle, or a styrenic resin comprising a crosslinked or graft rubber particle dispersed in a matrix resin (e.g., a rubber-reinforced styrenic resin such as a HIPS), as an additive of the styrenic resin. The rubber particle preferably includes, for example, a diene-series rubber particle such as a polybutadiene (butadiene rubber), an isoprene rubber, or a styrene-butadiene copolymer. For example, the rubber particle is preferably dispersed in a matrix comprising a styrenic resin by graft copolymerization or others. The proportion of such a rubber particle is about 3 to 50 parts by weight, preferably about 3 to 20 parts by weight, and more preferably about 5 to 10 parts by weight relative to 100 parts by weight of the styrenic resin. In particular, the combination of the crosslinked styrenic resin particle and the rubber-reinforced styrenic resin is used effectively.

The mean particle size of the particle is not particularly limited to a specific one as far as the particle is formable the projection, and for example, the

mean particle size is about 0.3 to 60 μm, preferably about 0.4 to 50 μm, and more preferably about 0.5 to 40 μm.

The conformation (or shape) of the particle is not particularly limited to a specific one, and may for example be a spherical shape, an elliptical shape, a polygonal shape, a prismatic shape, a columnar (or cylindrical) shape, a rod-like shape, a amorphous shape, or others.

The base resin sheet may comprise various additives, for example, a stabilizer (e.g., an antioxidant, a ultraviolet ray absorbing agent, a heat stabilizer), an antistatic agent, a crystal nucleus-growing agent, a hydrocarbon-series polymer, a plasticizer, a mineral oil, a filler, a coloring agent, and others.

The base resin sheet may be obtained by a conventional manner, for example, a conventional film-forming method such as a T-die or inflation method. The base resin sheet may be a non-oriented (or drawn) sheet, and is preferably an oriented (or drawn or stretched) sheet. The oriented film may be a uniaxially oriented film, and is preferably a biaxially oriented film. Moreover, if necessary, the oriented film may be heat-treated (or may be subjected to heat set treatment). The drawing method includes a conventional drawing or stretching method, for example, roll stretching, press stretching, belt stretching, tenter stretching, tube stretching and a combination method thereof. The draw ratio may be suitably set depending on property of sheet to be desired, and may

for example be about 1.2 to 20, preferably about 1.5 to 15, and more preferably about 1.5 to 10.

The surface of the base resin sheet may be subjected to a conventional finishing method, for example, corona discharge treatment, high-frequency treatment, and others. The surface tension of the base resin sheet depends on the species of sheet, and cannot be generalized as a specific value. In the case measuring in accordance with JIS (Japanese Industrial Standards) K-6768 "Wetting test of a polyethylene and polypropylene film", the surface tension is about 30 to 65 dyn/cm (30×10^{-5} N/cm to 65×10^{-5} N/cm). In the case of the styrenic resin, the surface tension is about 40 to 62 dyn/cm (40×10^{-5} N/cm to 62×10^{-5} N/cm), preferably about 42 to 62 dyn/cm (42×10^{-5} N/cm to 62×10^{-5} N/cm), and more preferably about 45 to 60 dyn/cm (45×10^{-5} N/cm to 60×10^{-5} N/cm).

The formation of the coating layer on the base resin sheet surface having such a surface tension improves adhesiveness of the coating membrane, and durability of the coating membrane of the sheet surface to water-exposure. Incidentally, when the surface tension of the sheet surface is too large, blocking tends to occur, probably because the sheet surface is too activated. Accordingly, it is difficult to roll up the rolled sheet. Moreover, when a plurality of shaped trays are stacked to punch out, each tray is contacted to the adjacent one, and as a result working efficiency for separating trays to store a content

in the tray tends to be adversely affected.

[Coated resin sheet or anti-fogging sheet, and process for producing the same]

The coated resin sheet of the present invention comprises the base resin sheet, a coating layer (or covering layer) formed by coating at least one side (one side or both sides) of the base resin sheet.

The coated resin sheet of the present invention, on which the coating layer is formed, has the following properties: the external appearance of the surface is excellent; even in the case rolling up, deterioration of anti-fogging property is small; and in addition high anti-fogging and antiblocking properties are ensured even by deep-draw molding. Moreover, even in the case subjecting to mold-processing (fabrication), the coated resin sheet can hold high anti-fogging property. Further, the amount of stain to a molding machine caused by the anti-fogging agent can be reduced.

The coating layer is usually formed by coating a liquid composition as a coating liquid or an impregnating liquid. Such a liquid composition may be a nonaqueous liquid composition containing an organic solvent as a solvent. The liquid composition may be usually utilized as an aqueous composition. Incidentally, in the aqueous composition, the solvent may be water alone, or a mixed solvent of water and a hydrophilic solvent (particularly a water-miscible solvent) [for example, an alcohol (e.g.,

methanol, ethanol, isopropanol), a ketone (e.g., acetone), an ether (e.g., dioxane, tetrahydrofuran), a cellosolve (e.g., methylcellosolve, ethylcellosolve, butylcellosolve), a carbitol].

The coating liquid of the coating layer may be prepared by a conventional mixing and stirring machine or mixing and dispersing machine. On the preparation, the silicone oil may be dispersed. The viscosity of the coating layer may be suitably selected so that coating property is deteriorated. The viscosity of the coating liquid may for example be not more than 5000 cps (= 5 Pa·s) [preferably about 100 to 3000 cps (= 0.1 to 3.0 Pa·s, and more preferably about 10 to 2500 cps (= 0.01 to 2.5 Pa·s)].

The coating layer of the present invention has such a characteristic that high anti-fogging and antiblocking properties are shown even at a small coating amount. Therefore, the coating amount of the coating layer (coating amount after drying) may for example be selected from a wide range of about 5 to 150 mg/m^2, and may be usually about 10 to 100 mg/m^2, preferably about 15 to 80 mg/m^2 (e.g., about 20 to 70 mg/m^2), and more preferably about 20 to 50 mg/m^2. Even when the coating amount is about 10 to 50 mg/m^2, high anti-fogging and antiblocking properties are realized.

In the coated resin sheet of the present invention, it is sufficient that the coating layer may be formed on at least one side of the base resin sheet, and it is preferred that one side of the base resin sheet is coated

with the coating layer and the other side is treated with corona discharge to give a surface tension of about 30 to 55 dye/cm (30 x 10^{-5} to 55 x 10^{-5} N/m). The other side may be further treated (or coated) with various treating agents (e.g., a coating agent containing an antiblocking agent for improving antiblocking property, an antistatic agent or a lubricant for increasing antistatic property or slipping property, or other agents). In particular, the coating layer may be formed on one side of the base resin sheet and the release layer (or antiblocking layer) may be formed on the other side.

In the present invention, the release layer (or antiblocking layer) comprises a silicone oil. As the silicone oil, a silicone oil similar to one as described above (e.g., a dimethylpolysiloxane) is preferred. In the preferred embodiment, the silicone oil may be used in an emulsion (aqueous emulsion) form as described above.

The release layer may comprise the silicone oil, and in addition a variety of mold-releasing agents (or antiblocking agent), for example, a wax (including a mineral-series wax, a plant-series wax, a synthetic wax, and others), a higher fatty acid amide, etc., and preferably comprises an ether-series hydrophilic polymer having an oxyethylene unit. As the ether-series hydrophilic polymer having an oxyethylene unit, there may be used an ether-series hydrophilic polymer (e.g., a nonionic surfactant, e.g., a polyoxyethylene-polyoxypropylene

block copolymer, a nonionic surfactant having an oxyethylene unit) as described above. The proportion of the various mold-releasing agents may be selected within such a range that the anti-fogging property or antiblocking property is not deteriorated, and is about 0 to 100 parts by weight relative to 100 parts by weight of the silicone oil.

Incidentally, the treating agent such as a mold-releasing agent may comprise various additives, for example, a stabilizer (e.g., an antioxidant, a ultraviolet ray absorbing agent), a filler, a coloring agent, an antistatic agent, a flame retardant, a lubricant, a wax, an antiseptic agent, a viscosity adjustment (or viscosity controller), a thickening agent, a leveling agent, an antifoaming agent, and others. Moreover, the treating agent may be usually employed in a form such as coating liquid or an impregnating liquid, and may be a nonaqueous liquid composition containing an organic solvent as a solvent. The treating agent may be usually utilized as an aqueous composition. Incidentally, in the aqueous composition, the solvent may be water alone, or a mixed solvent of water and a hydrophilic solvent described above (particularly a water-miscible solvent).

The coating amount of the treating agent (coating amount after drying) may be selected from a wide range of about 1 to 200 mg/m^2 (e.g., about 5 to 100 mg/m^2) depending on the species of treating agent, and may be usually about

2 to 100 mg/m^2, preferably about 3 to 50 mg/m^2 (e.g., about 5 to 30 mg/m^2), and more preferably about 5 to 25 mg/m^2.

A projection similar to the projection on the coating layer is also preferably formed on the surface treated with the treating agent (e.g., the mold-releasing agent). The method forming the projection on the release layer includes a method using a base resin sheet having a projection formed on the surface in the same manner as in the case of the coating layer.

The coated resin sheet may be produced by applying or coating the coating liquid of the coating layer (or anti-fogging layer) on at least one side of the base resin sheet. Moreover, the coated resin sheet may be also produced by applying or coating the coating liquid on one side of the base resin sheet and applying or coating the treating agent (e.g., a mold-releasing agent, an antiblocking agent) on the other side of the base resin sheet. In the coating of the coating liquid (or treating agent) of the coating layer, a conventional coating manner, e.g., a spray, a roll coater, a rotogravure roll coater, a knife coater, a dip coater, or others may be utilized. Incidentally, if necessary, the coating liquid (or the treating agent) of the coating layer may be coated over multiple times. The coated layer (or anti-fogging layer) or treated layer (e.g., a mold-releasing layer) may be formed by coating the coating liquid (or the treating agent) of the coating layer on the base resin sheet, and then

usually drying the coated layer.

The coated resin sheet may be successively subjected to a post-treatment step (e.g., a tray-shaping step), and is often rolled up in a roll form and then subjected to a post-treatment step. Even in such a roll-up step, the coated resin sheet is significantly prevented from transferring of the anti-fogging component depending on high antiblocking property, is excellent in anti-fogging property at low temperature as well as anti-fogging property at high-temperature, and maintains high anti-fogging property over a long period. Further, the coated resin sheet can be prevented from tack or whitening, and keeps transparency or luster thereof. Therefore, the coated resin sheet can be utilized for various applications, for example, a cover sheet (or film), a packaging sheet (or film) such as a food packaging sheet, and others. The coated resin sheet using a base resin sheet having high formability (or shapability) has high secondary shapability, and is suitable for mold-processing (or fabrication) of a tray or others.

[Tray and production process thereof]

The present invention also discloses a shaped article such as a tray or a container (e.g., a tray for food packaging) formed (or molded) with the coated resin sheet. Moreover, the tray usually has at least a tray body for storing a content such as food, and the opening of the tray body may be covered with a wrapping film. Further,

the tray may comprise a tray body and a cover for covering the opening of the tray body through a hinge.

In the preferred method, the tray (e.g., a tray for storing a content containing water, such as a food packaging tray) is formed with the coated resin sheet (or anti-fogging sheet) by a conventional heat forming (or shaping) method in many cases. As the heat forming (or molding) method (or secondary mold-processing method), for example, a blow molding, a vacuum molding, a pressure molding (e.g., a heat and pressure molding such as a heating-mode pressure molding with hot plate, or a radiation heating-mode pressure molding), a vacuum and pressure molding, a plug assist molding, or a matched-mold molding may be utilized. In the case using the oriented resin sheet, the pressure molding with hot plate is often utilized.

According to the present invention, even in the case subjecting the coated resin sheet to such a heat molding (secondary molding), the coated resin sheet can maintain high anti-fogging property and antiblocking property. In particular, even in the case subjecting the coated resin sheet to deep molding, the coated resin sheet is excellent in anti-fogging property at high temperature and anti-fogging property at low temperature, and can maintain high anti-fogging property.

Incidentally, the content storable into the secondary-molded tray is not particularly limited to a

specific one. Although the content may be a dried content or a content in which water vaporization is low, the tray is suitable for storing a content containing water (e.g., a food) because of high anti-fogging property. Further, the tray of the present invention is also suitable for a tray to be used under an environment in which dew condensation tends to occur (e.g., a tray for storing a perishable food or prepared food maintained at a low temperature, in addition a cooked food). Incidentally, even in the case subjecting the tray to the heat molding, the tray ensures high transparency and luster, and is improved in visibility of the content.

According to the present invention, combinations of specific structure and specific components significantly improve anti-fogging property (high temperature anti-fogging property and low temperature anti-fogging property) and antiblocking property. In particular, even in the case subjecting the sheet of the present invention to roll up or heat molding, the sheet can maintain high anti-fogging property, and can be enhanced in mold-releasing property (or antiblocking property). Further, high mold-releasing property (or antiblocking property) is imparted to the sheet in spite of a small amount of the silicone oil. Moreover, the amount of stain on a molding machine by the anti-fogging agent can be reduced.

EXAMPLES

The following examples are intended to describe this invention in further detail and should by no means be interpreted as defining the scope of the invention. Incidentally, in Examples and Comparative Examples, the following components were used.

[Polyhydric alcohol fatty acid ester]

A-1: Sucrose laurate (manufactured by Riken Vitamin Co., Ltd., "RIKEMAL A", HLB = 15)

A-2: Polyglycerin fatty acid ester (manufactured by Riken Vitamin Co., Ltd., decaglycerin monolaurate "Poem J-0021", HLB = 15.5)

[Hydrophilic polymer]

B-1: Carboxymethylcellulose sodium CMC (manufactured by Daicel Chemical Industries, Ltd., "CMC Daicel 1350")

B-2: Hydroxypropylmethylcellulose HPMC (manufactured by Shin-Etsu Chemical Co., Ltd., "METOLOSE 60SH-15", viscosity of 2 wt.% aqueous solution = 13 to 18 mPa·s, mean substitution degree of methyl group = 1.9, and mean substitution degree of hydroxypropyl group = 0.25)

B-3: Sodium polyacrylate PAcNa (manufactured by Nippon Shokubai Co., Ltd., "AQUALIC FH-G", weight-average molecular weight = 400×10^4 to 500×10^4)

B-4: Polyvinylpyrrolidone (manufactured by BASF Japan Ltd., "Luvitec K-90", weight-average molecular weight = 90×10^4 to 150×10^4, and viscosity of 5 wt.% aqueous solution = 80 to 100 mPa·s)

B-5: Polyvinyl alcohol PVA (manufactured by Kuraray Co., Ltd., "PVA205")

B-6: Polyoxyethylene-polyoxypropylene block copolymer (manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd., "EPAN 785", weight-average molecular weight = 13000, content of oxyethylene (or ethylene oxide) chain = 85 wt.% (%))

[Silicone oil]

Dimethylsilicone aqueous emulsion (manufactured by Shin-Etsu Chemical Co., Ltd., "KM9738", 10000 centistokes = 100×10^{-4} m^2/s)

Moreover, in a coated resin sheet, the height of a projection in the coated resin sheet, the anti-fogging property after pressing, and the anti-fogging property of a shaped article formed with the sheet were evaluated as follows.

[Average density (or number) of projection]

In each sheet (1.5 mm x 1.5 mm), the three-dimensional roughness was measured (n=3) by a surface roughness gauge (manufactured by TOKYO SEIMITSU CO., LTD., SURFCOM 1400A) to count the number of a projection having a height of 0.2 to 2 μm, and the density (or number) was converted into the average density (or number) of the projection per square millimeter.

[Anti-fogging property after pressing]

A coated resin sheet was cut into 30 centimeters square. Two sheets of the cut sheet were overlapped so that an anti-fogging surface of one sheet was facing to a

mold-releasing surface of another sheet (that is, the anti-fogging surface of the upper sheet and the mold-releasing surface of the lower sheet were contacted with each other), and pressed at a temperature of 30°C for one hour under a load of 10 kgf/cm^2 (≒ 98 N/cm^2) with the use of a hand-operated press machine. Then, the applied pressure was released, and the sheets were separated. In the upper sheet, the sheet was put on a container charged with 60°C water so that the surface of the sheet coated with the anti-fogging agent was faced to the opening of the tray to steam the surface. The sheet was allowed to stand for 2 minutes under a room temperature, and the fogging degree of the sheet was visually observed and evaluated based on the following criteria.

"A": The profile of the content can be sharply defined.

"B": The profile of the content can be almost defined.

"C": The profile of the content can be recognized.

"D": Not see-through.

[Anti-fogging property of shaped article]

The sheet was subjected to a hot plate forming (or shaping) to form a circular cover having 100 mm in diameter and 30 mm in depth (drawing ratio: 0.3). The circular cover was put on a container charged with 23°C water, and allowed to stand for 10 minutes under an environment of 5°C. Then, the fogging degree of the cover was visually observed and

evaluated based on the following criteria.

"A": The word "anti-fogging property" having font size 5 can be read.

"B": The word "anti-fogging property" having font size 10 can be read.

"C": The word "anti-fogging property" having font size 14 can be read.

"D": The word "anti-fogging property" having font size 18 can be read.

Examples 1 to 8 and Comparative Examples 1 to 4

In each of Examples and Comparative Examples, one side of a biaxially stretched or oriented polystyrene sheet having the number of a projection shown in Table 1 (sheet thickness of 0.25 mm) was subjected to corona discharge treatment for giving a surface tension of 60 dyn/cm (60 x 10^{-5} N/cm). Aqueous anti-fogging treating agents containing each component at a proportion (parts by weight) shown in Table 1 were prepared (a silicone oil was estimated as a corresponding value in solid matter). Each of these anti-fogging treating agents was coated on the corona discharge treated surface, and dried to form a given anti-fogging layer. Further, the other side of the biaxially stretched or oriented polystyrene sheet was subjected to corona discharge treatment to reach a wetting index shown in Table 1. Moreover, in Examples 5 to 7, the silicone oil was coated as a mold-releasing agent on the corona discharge treated surface at a proportion (parts

by weight) described in Table 1 as a solid matter, and dried to form a given release layer. The results are shown in Table 1.

Table 1

		Examples								Comparative Examples			
		1	2	3	4	5	6	7	8	1	2	3	4
Anti-fogging treating agent	Polyhydric alcohol fatty acid ester (parts by weight)	A-1 100	A-1 100	A-1 100	A-1 100	A-1 100	A-1 80 A-2 20	A-1 100	A-1 100	A-1 100	A-1 100	A-1 100	A-1 100
	Hydrophilic polymer (parts by weight)	B-1 10	B-2 30	B-3 15	B-2 5 B-4 5	B-4 10	B-4 10	B-1 10 B-6 30	B-4 10 B-6 20	—	—	—	B-5 10
	Silicone oil	5	10	15	50	10	20	10	—	20	15	—	—
	Coating amount (mg/m^2)	30	40	35	45	30	20	35	30	30	40	40	30
Mold-releasing agent	Silicone oil	—	—	—	—	100	100	100	100	—	—	—	—
	Coating amount (mg/m^2)	—	—	—	—	15	5	10	10	—	—	—	—
Wetting index of mold-releasing surface (dyn/cm)		35	40	33	45	35	50	33	33	35	62	62	62
Average number of projection ($number/mm^2$)		10	15	12	5	10	30	15	25	12	2	5	3
Anti-fogging property after pressing		A	A	A	A	B	B	A	A	C	D	D	C
Anti-fogging property of shaped article		A	A	A	A	B	B	A	A	C	D	D	D

As apparent from Table 1, the coated resin sheets of Examples are excellent in not only anti-fogging property after pressing, but also anti-fogging property of the shaped articles.